Lambda Expressions in Java 8 Sessions Report

Arkady Galyash

dxChartPro

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Agenda

1. Lambda Intro
2. Lambda Expression
3. Interface Evolution
4. Library Changes
5. Lambda in JVM
6. Links

Why Lambda Project is so popular?

- Huge language and library improvements
- Perhaps the biggest upgrade ever to the Java programming model
- We want to treat code as data

What is a Lambda Expression?

Lambda expression(closure) is an anonymous method

- has an argument list, a return type, a body
- can refer values from the enclosing lexical scope
- not a member of a class - just free-floating expression

Who needs Lambda Expressions?

- C++ added them
- C# added them
- Scala, Groovy, Clojure, Kotlin, ...

> In another thirty years people will laugh at anyone who tries to invent a language without closures, just as they'll laugh now at anyone who tries to invent a language without recursion.
>
> — Mark Jason Dominus, "The Perl Review"

How Lambda Expression looks like?

Talk is cheap. Show me the code.

What have been done?

JSR-335 =

- Lambda Expression
- Interface Evolution
- Bulk Collection Operations

Study calculation example

- Chart with some studies
- Study can be calculated
- Some studies are visible and some are hidden
- New bars have come - we need to recalculate studies

What is changed?

- Library is in control(parallelism, laziness)
- Behavior have been passed into the API as data
- Internal iteration
- More what, less how

How much syntax sugar do we have?

- Remove curly brackets and return for single expression
- Type argument inference
- Method reference
  `Classname::methodName`
- Expression method reference
  `Expression::methodName`
- Effectively final local variables

What about type?

- Now we are using single-method interfaces to represent functions:
  Runnable, Comparator, ActionListener
- Let's give these a name: functional interfaces
- We need more functional interfaces:
  Predicate, Block, etc.
- Everything we wrote before will work with lambda for free

Interface evolution

`Collection::forEach`

`(Block<? super E>)`

What is this?

Interface inheritance rules

- ArrayList VS List

Interface inheritance rules

- ArrayList > List "superclass always wins"

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- ArrayList > List "superclass always wins"
- List VS Collection

Interface inheritance rules

- ArrayList > List "superclass always wins"
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Interface inheritance rules

- ArrayList > List "superclass always wins"
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- List VS Set

Interface inheritance rules

- ArrayList > List "superclass always wins"
- List > Collection "subtype wins"
- List == Set write your implementation

Diamond problem

java.util.Collection

- `void forEach(Block<? super E>)`
- `boolean removeIf(Predicate<? super E>)`
- `Stream<E> stream()`
- `Stream<E> parallel()`

java.util.stream.Stream

Methods for FP-lovers

- `<R> Stream<R> map(Mapper<? super T, ? extends R> mapper);`
- `<R> Stream<R> flatMap(FlatMapper<? super T, R> mapper);`
- `Stream<T> filter(Predicate<? super T> predicate);`

java.util.stream.Stream #2

Terminal methods

- `<U> U fold(Factory<U> baseFactory, Combiner<U, T, U> reducer, BinaryOperator<U> combiner);`
- `T reduce(T base, BinaryOperator<T> op);`
- `Optional<T> reduce(BinaryOperator<T> op);`
- `<A extends Destination<? super T>> A into(A target);`

Parallel Stream

- Stream<E> parallel()
- Over fork/join framework
- java.util.streams.Spliterator provides the ability to decompose an aggregate data structure and to iterate over the elements of the aggregate

Lambda in JVM

Lambda is just sugar?

We could say that a lambda is "just" an inner class instance.

Pros:

- Simple, quick and dirty
- We use that already worked

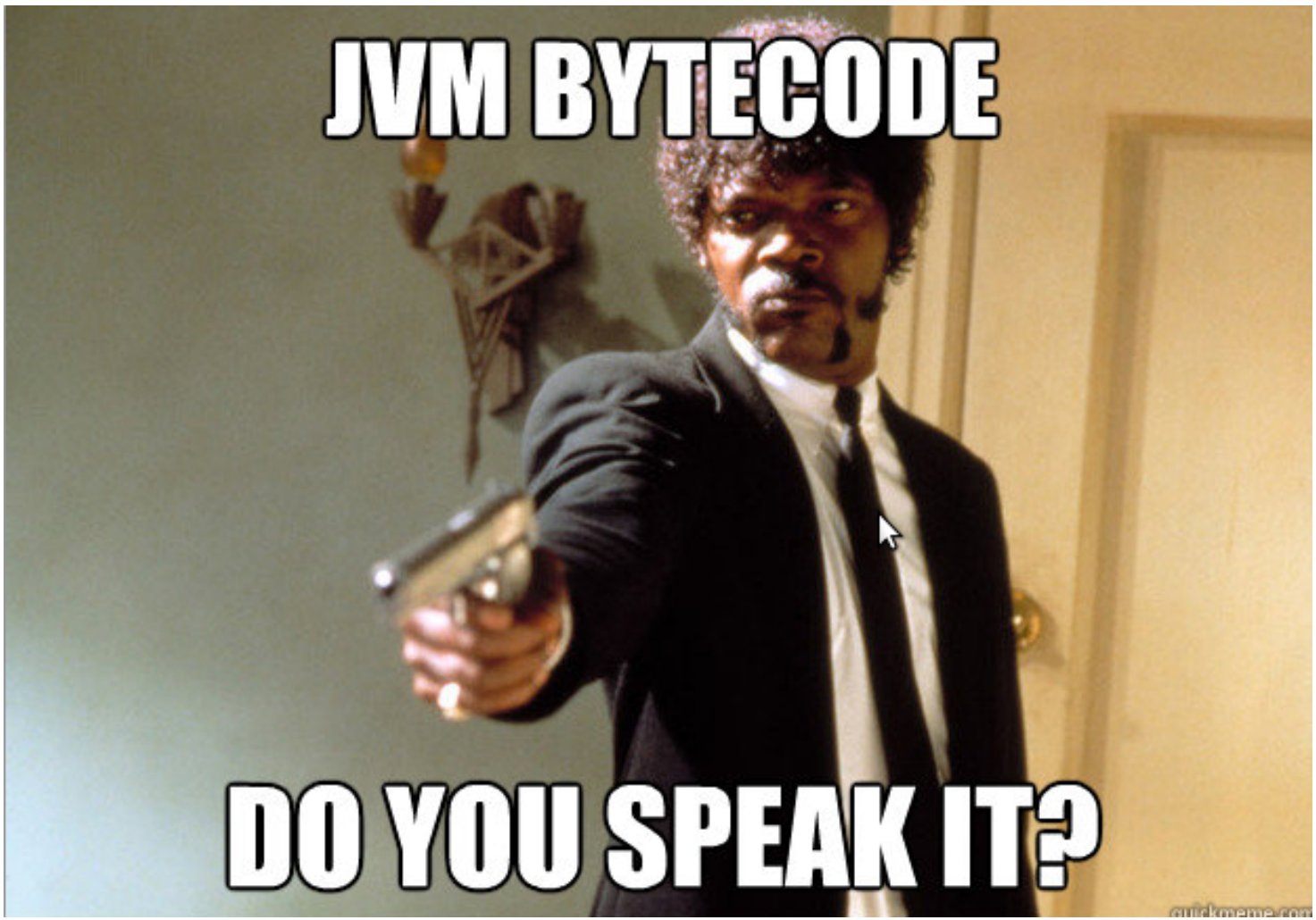
Lambda is just sugar?

We could say that a lambda is "just" an inner class instance.

Cons:

- One class per lambda expression(performance issues)
- Whatever we do becomes a binary representation for lambdas in Java(forever)

JVM Bytecode



Bytecode invocation modes

Prior to Java 7, the JVM had four bytecodes for method invocation

- invokestatic - for static methods
- invokevirtual - for class methods
- invokeinterface - for interface methods
- invokespecial - for everything else

java.lang.invoke.MethodHandle

- From Java7
- Typed, directly executable reference to an underlying method or similar low-level operation, with optional transformations of arguments or return values
- Can be saved into runtime constant pool of the class and loaded with LDC
- Sounds like lambda

java.lang.invoke.MethodHandle

```
list.removeAll(...)
```

```
private static boolean lambda$1(...) { ... }
```

```
MethodHandle mh = LDC[lambda$1];
mh = mh.insertArguments(mh, ...);
list.removeAll(mh);
```

java.lang.invoke.MethodHandle

Cons:

- Signature will be
  void removeAll(MethodHandle predicate)
- Erasure worse than with generics(all lambda are the same)
- Whatever we do becomes a binary representation for lambdas in Java(forever)

invokedynamic

- From Java7
- Let some "language logic" determinate call target
- Language and VM become partners in flexible and efficient method dispatch
- java.lang.invoke.CallSite

indy and Lambda

- indy lets us separate the binary representation of lambda creation in the bytecode from the mechanics of evaluating the lambda expression at runtime
- Instead of generating bytecode to create the object that implements the lambda expression (such as calling a constructor for an inner class), we describe a recipe for constructing the lambda, and delegate the actual construction to the language runtime

java.lang.invoke.LambdaMetafactory

- Bootstrap for the lambda factory selects the translation strategy
- The runtime implementation choice is hidden behind a standardized API for lambda construction(invokedynamic)

java.lang.invoke.LambdaMetafactory

Talk is cheap. Show me the ~~code~~ bytecode.

Desugaring Lambda

- For "stateless" lambda - generate private static method at the same class with the signature of SAM
- For lambda capturing immutable values - generate private static method at the same class with the signature of SAM + additional captured parameters
- For lambda with this, super, etc. - generate private method of the same class with the signature of SAM

Lambda Serialization

Lambda Serialization

- Dynamic translation strategy mandates a dynamic serialization strategy
- The serialized form(java.lang.invoke.SerializedLambda) would have to contain all the information needed to recreate the object through the metafactory

HowTo play with Lambda?

- Project Lambda
- hg repository
- Binary snapshots
- -XDlambdaToMethod

What to read about Lambda?

- State of the Lambda v4
- Defender methods v4
- State of the Lambda: Libraries Edition
- Translation of Lambda Expressions
- CON4862, CON6080

Thank You!